REMARKS

This application has been carefully reviewed in light of the Office Action dated October 19, 2004. Claims 1, 3 to 6, 11 and 12 are pending in the application, of which Claims 1, 6, 11 and 12, are independent. Reconsideration and further examination are respectfully requested.

As an initial matter, Applicant thanks the Examiner for the courtesies extended to Applicant's representative in a telephonic interview of February 8, 2005. During that interview, the Examiner reiterated his reasoning for rejecting all of the pending claims in the application.

Claims 1, 3 to 6, 11 and 12 were rejected under 35 U.S.C. § 103(a) over U.S. Patent No. 5,883,821 (Komaki). Reconsideration and withdrawal of this rejection is respectfully requested.

The present invention concerns color conversions using non-uniform multi-dimensional look-up tables and integer computations. Specifically, Claim 1 is directed to:

> A data conversion method of performing image processing on image data expressed in plural components by using a multi-dimensional look-up table, and outputting processed image data, comprising the steps of:
>
> setting grid positions of the multi-dimensional look-up table which has grids arranged at non-uniform intervals;
>
> generating a weight table to store weight values corresponding to the plural components based on the set grid positions, wherein the weight values are calculated by an integer computation, and are multiplied by a constant which

is a large value greater than a value corresponding to a maximum interval of the grids;

obtaining the weight values corresponding to the plural components of input image data by referring to the weight table;

obtaining output data of grid points of the multi-dimensional look-up table which corresponds to the input image data;

calculating the processed image data, which corresponds to the input image data, by interpolation using the obtained output data, the obtained weight values and the constant, wherein the interpolation is executed by an integer computation and uses the constant as a divisor.

In the Office Action, at Pages 2 and 5, it is contended that Komaki discloses all of the claim limitations of Claim 1 save the use of integer computation. In response, the Examiner is respectfully referred to MPEP § 2141 *et seq*. More particularly, as set forth in MPEP § 2143.03, in order to establish a *prima facie* case of obviousness, all the claim limitations must be taught or suggested by the prior art. Furthermore, "(a)ll words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970).

Applicant submits that the Office Action fails to prove that the prior art as modified by the Examiner teaches or suggests all of the claim limitations of Claim 1. In addition, during the interview, the Examiner was unable to provide the required proof. Specifically,

Komaki as modified in the Office Action fails to teach or suggest at least the following features of Applicant's claimed invention:

- setting grid positions of the multi-dimensional look-up table which has grids arranged at non-uniform intervals;
- generating a weight table to store weight values corresponding to the plural components based on the set grid positions, wherein the weight values are calculated by an integer computation, and are multiplied by a constant which is a large value greater than a value corresponding to a maximum interval of the grids;

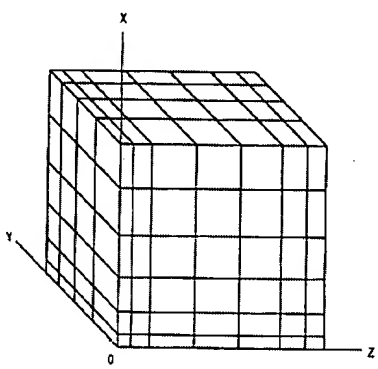
  or
- calculating the processed image data, which corresponds to the input image data, by interpolation using the obtained output data, the obtained weight values and the constant, wherein the interpolation is executed by an integer computation and uses the constant as a divisor.

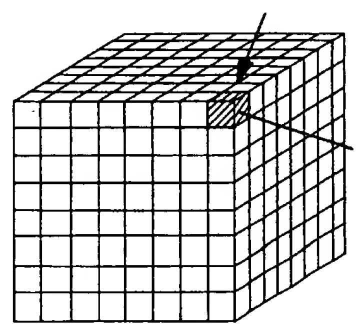
At Page 3 of the Office Action, it is contended that Komaki teaches "setting grid positions (selecting the grid positions) of the multi-dimensional look-up table" at Column 1, lines 61 to 67 of Komaki. However, this portion of Komaki does not include a disclosure of the actual claim limitation which is:

> setting grid positions of the multi-dimensional look-up table **which has grids arranged at non-uniform intervals**.

Contrary to the assertions made in the Office Action, nowhere in the cited portion of Komaki is it disclosed that a multi-dimensional look-up table which has grids arranged at non-uniform intervals is used during a color conversion process. Instead, Komaki, explicitly discloses the use

of a look-up table having uniform grid intervals. The diagram below illustrates the difference between a look-up table having non-uniform grid structure as in the present invention and a look-up table having a uniform grid structure as disclosed by Komaki. A look-up table having a non-uniform grid structure is shown on the left in the diagram and a look-up table having a uniform grid structure is shown on the right in the diagram. As can be seen from the side-by-side comparison of the two different types of look-up tables, the look-up table having uniform grid intervals can be divided into equally sized cubes having faces of identical size whereas the look-up table having non-uniform grid intervals can only be divided up into regular rectangular hexahedra.





INPUT GRID

During the interview, the Examiner attempted to correct the failure in the Office Action to address the non-uniform grid interval features of the invention by citing to Column 2, lines 1 to 25 of Komaki, of which the whole of the cited portion is as follows:

> An arithmetic expression for interpolation in a linear interpolation can be generally expressed as follows:

$$\sum_{i=1}^{k} CiVui$$

wherein k is a number of grid points to be utilized for the interpolation, v_{ui} is a value indicated by the data of grid point ui, and c_i is a weighting coefficient.

For example, when k is eight, the interpolation to be performed becomes an eight point interpolation using eight grid point data. In this case, the interpolation space becomes cubic. On the other hand, when k is five, the interpolation to be performed becomes a five point interpolation using five grid point data. The shape of the solid body to express the interpolation space is then variable depending upon selection of the five grid points. When k is preliminarily determined as set forth above, and the input signals R, G, B are expressed as byte data, the grid point data v_{ui} to be used are output from the LUT on the basis of the predetermined upper bits of the input signals R, G, B, and, on the other hand, the weighting coefficient c_i in the foregoing expression is determined on the basis of the lower bit data indicative of a position of the input signals in the interpolation space, for example.

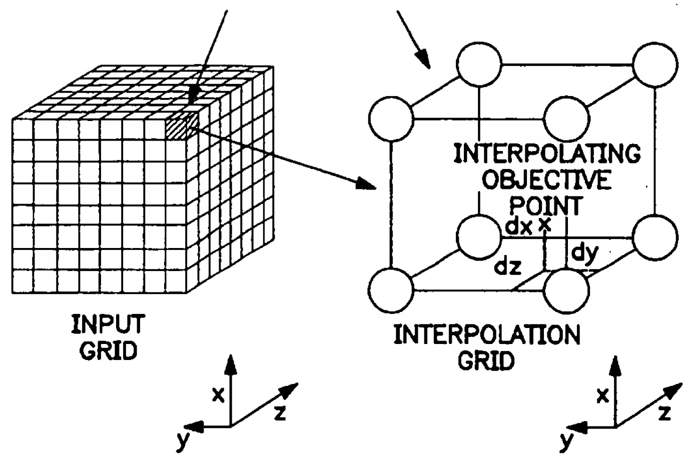
As can be seen from above, the cited portions of Komaki merely disclose that linear interpolations can be performed using a variable number of points. However, the Examiner asserted that because Komaki disclosed using a variable number of grid points for linear interpolation, as indicated by the variable k, that this somehow was the same as teaching or

suggesting the use of look-up tables with non-uniform grid intervals. Applicant submits that nowhere in the cited portions of Komaki are look-up tables with non-uniform grid intervals taught or suggested. In fact, the cited portion of Komaki never even discusses grid intervals, uniform or otherwise.

When it was pointed out to the Examiner that the cited portion of Komaki does not address non-uniform grid intervals, the Examiner then relied on figures from Komaki which allegedly show use of a look-up table with non-uniform grid intervals. However, the figures do not show look-up tables with non-uniform grid intervals, instead, the figures are 2-dimensional projections of different perspective views of 3-dimensional geometric solids taken from an interpolation grid which is taken from a look-up table having uniform grids. These projections do not teach use of a grid having non-uniform grid intervals as is discussed below.

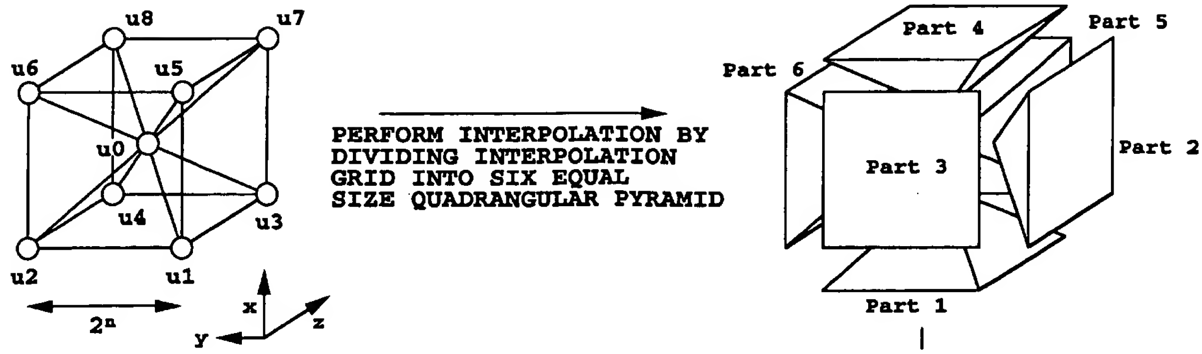
Komaki is concerned with the use of pyramidal or five point interpolation used in a color conversion process. To illustrate use of the quadrangular pyramids selected for the interpolation process, Komaki discloses selecting an interpolation grid from an input grid having uniform intervals and then segmenting the interpolation grid into six quadrangular pyramids.

The process of segmentation is depicted below in a series of diagrams taken from Komaki. In a first step, an interpolation cube is selected from the input grid (the illustration is taken from FIG. 2 of Komaki):

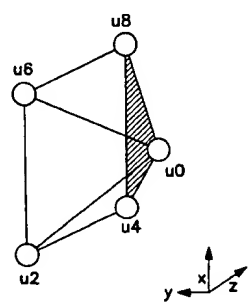


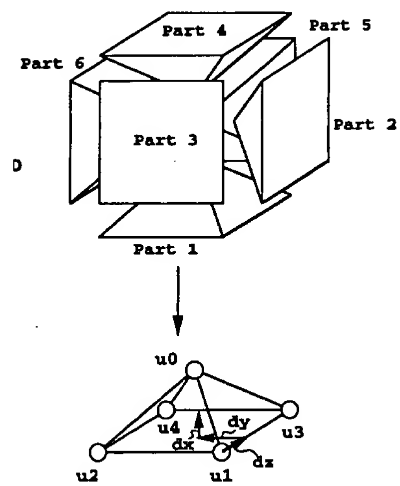
As disclosed by Komaki, an interpolation grid composed of eight grid points is taken from an input grid having a uniform grid interval. The eight grid points selected from the input grid are selected on the basis that a volume, defined by the eight grid points, encloses the input interpolating objective point. As the interpolation grid is composed from eight points selected from the look-up table having uniform grid intervals, each grid point pairing spans exactly one grid interval along one dimension of the input grid. Thus the interpolation grid spans one grid interval in each dimension of the input grid.

The interpolation grid is then segmented to generate a set of quadrangular pyramids that can be used in a pyramidal interpolation process. The segmentation of the interpolation grid is shown below (the illustration is taken from FIG. 3 of Komaki):



As can be seen from the foregoing illustrations, Komaki discloses how a look-up table having uniform grid intervals is used to determine an interpolation grid that is segmented into six quadrangular pyramids having equally sized bases. These quadrangular pyramids are illustrated in various projections as the interpolation process is further described. For example, two of the projections, corresponding to "part 1" and "part 6" are shown below:





As illustrated above, the quadrangular pyramids are 3-dimensional objects that are shown as projections onto a 2-dimensional plane. Throughout the remainder of Komaki, as illustrated in FIG. 4 to FIG. 37, the six quadrangular pyramids are shown using different rotations and perspectives thus resulting in different projections onto a 2-dimensional plane as required to depict the 3-dimensional object on a flat piece of paper. In each of the projections, the edges that form the bases of the pyramids are shown as line segments joining two grid points taken from the interpolation cube. In some of these projections, it appears that the edges are not equal in length. This apparent difference in length is because of the projection of the 3-dimensional objects onto a 2-dimensional surface and not because the grid points are selected from a look-up table having non-uniform grid intervals. In Komaki, there is no actual difference in distance between grid point pairs that define an edge of the base of the quadrangular pyramids because the interpolation grid from which the quadrangular pyramids are taken is taken from a look-up table having uniform intervals. Therefore, Komaki does not disclose look-up tables having non-uniform grid intervals simply because projections of the 3-dimensional quadrangular pyramids have line segments the appear to be unequal in length.

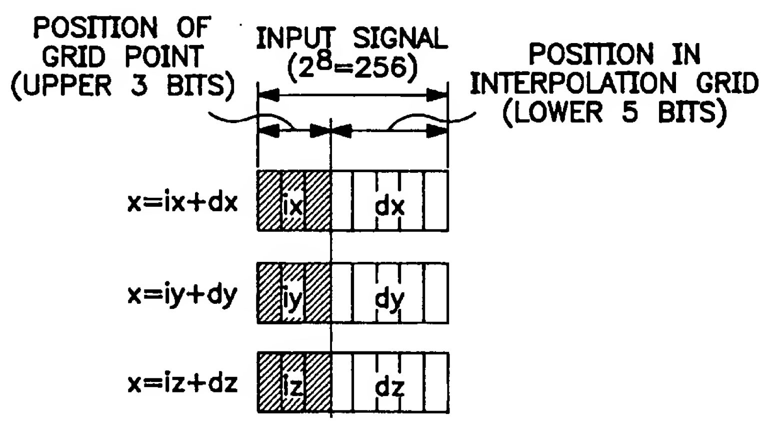
The Office Action also incorrectly asserts that Komaki discloses:

- generating a weight table ... wherein the weight values ... are **multiplied by a constant which is a large value greater than a value corresponding to a maximum interval of the grids**; and
- calculating the processed image data ... using ... **the constant as a divisor**.

The Office Action cites Columns 9 to 13 as a portion of Komaki that discloses such a constant. However, these portions of Komaki disclose a general interpolation function that may be used for

the specific input signal encoding used by Komaki. These functions do not include the use of a constant greater than a value corresponding to a maximum interval of the grids as claimed by Applicant as discussed below.

In FIG. 2 and its related discussion, Komaki discloses use of an input signal composed of binary values encoding the position of a reference point defining an interpolation grid in a larger look-up table. The same input signal is also used to encode the position of an interpolating objective point within the interpolation grid. This position is encoded as the difference or delta along each dimension of the look-up table between the interpolating objective point and the reference point. As shown in the illustration below (taken from FIG. 2 of Komaki), the upper bits of the an input signal value encode the position of the reference grid point and the lower bits of the input signal value encode a position of the interpolating objective point within the interpolation grid:



In the example above, the position of the reference grid point along one dimension of a three-dimensional look-up table is encoded as the upper three bits of an eight bit input signal value. In addition, the position of an objective interpolation point along one dimension within

the interpolation grid is encoded using the lower five bits of the eight bit input signal value. Accordingly, three input signal values are used, one input signal value for each dimension of the look-up table from which the interpolation grid is taken. This results in values having a range of 0 to 2^5 used to encode the position of the objective interpolation point within the interpolation grid. More generally, if n is the number of low order bits used to encode the position of the objective interpolation point within the interpolation grid, then the encoding scheme provides for a value having a range of 0 to 2^n. As the interpolation grid spans one grid interval of the input look-up table, the encoding scheme thus establishes a value for one grid interval of the look-up table as 2^n.

Komaki further discloses how interpolations are performed using the encoding scheme. At Column 10, starting at line 1, the general equation is given as:

$$
\begin{aligned}
(v_{u0} \times (2 \times dx) \quad + \quad & (v_{u1} \times (2^n - dy - dx) \times (2^n - dz - dx) + \\
& v_{u2} \times (dy - dx) \times (2^n - dz - dx) + \\
& v_{u3} \times (2^n - dy - dx) \times (dz - dx) + \\
& v_{u4} \times (dy - dx) \times (dz - dx))/(2^n - 2 \times dx))/2^n
\end{aligned}
$$

The above equation is simply an expanded version of the interpolation equation $\sum_{i=1}^{k} CiVui$ for the case where k = 5 and using the nomenclature introduced by the encoding scheme. As explained above, as the variables *dx*, *dy*, and *dz* span at most one grid interval, they have values ranging from 0 to 2^n. Thus, these values are normalized by subtracting the values of the variables from 2^n and then dividing the result by 2^n. It is this use of 2^n that the Office Action characterizes as the

same as Applicant's use of a constant which is a large value greater than a value corresponding to a maximum interval of the grids as both a multiplier when creating the weight values and as a divisor when interpolating using the weight values.

Applicant submits that this characterization is inaccurate on at least two counts. Firstly, the claimed feature includes weight values **multiplied by a constant** and then using the constant **as a divisor** during an interpolation process. As clearly shown by the interpolation discussion in Komaki, the values of *dx*, *dy* and *dz* are subtracted from 2^n and the whole result is then divided by 2^n. Secondly, the claimed feature describes **a constant which is a large value greater than a value corresponding to a maximum interval of the grids**. As discussed above, Kokami's value of 2^n represents the grid interval distance of the look-up table from which the interpolation grid was taken. Therefore, 2^n as used in Komaki cannot be a **large value greater than a value corresponding to a maximum interval of the grids** because 2^n is the value corresponding to the interval of the grid in the look-up table of Komaki.

As detailed above, Komaki fails to disclose at least the features of setting grid positions of the multi-dimensional **look-up table which has grids arranged at non-uniform intervals**, generating a weight table to store weight values corresponding to the plural components based on the set grid positions, wherein the weight values are calculated by an integer computation, and are **multiplied by a constant which is a large value greater than a value corresponding to a maximum interval of the grids**, and calculating the processed image data, which corresponds to the input image data, by interpolation using the obtained output data, the obtained weight values and the constant, wherein the interpolation is executed by an integer computation and uses the **constant as a divisor**. Furthermore, modifying Komaki as suggested

in Office Action, namely introducing integer computation, fails to cure the deficiencies of Komaki.

Therefore, the Office Action fails to establish a *prima facie* case of obviousness as required under MPEP § 2143.03, namely, the prior art does not teach or suggest all of the limitations of Applicant's Claim 1. Accordingly, Applicant submits that Claim 1 is allowable and respectfully requests same.

Independent Claims 6, 11 and 12 are directed to a data conversion apparatus, a computer readable medium having a computer program code and a computer readable medium storing recorded data which is used in data conversion processing to process image data, respectively, implementing the features of the method of Claim 1. As such, Applicant submits that Claims 6, 11 and 12 are also in condition for allowance and respectfully requests same.

Each of the remaining claims is dependent upon at least one of the claims discussed above and are, therefore, believed to be allowable for at least the same reasons. Because each dependent claim is also deemed to define an additional aspect of the invention, however, individual consideration of each dependent claim on its own merits is respectfully requested.

In view of the foregoing remarks, and no other matters being raised in the Office Action, the entire application is believed to be in condition for allowance, and such action is respectfully requested at the Examiner's earliest convenience.

Applicant's undersigned attorney may be reached in our Costa Mesa, CA office at (714) 540-8700. All correspondence should continue to be directed to our below-listed address.

Respectfully submitted,

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